Day 3 - Water Quality Vital Signs Breakout Session

(Moderator – Pete Penoyer)

- Lessons Learned on Sondes – (Pete Penoyer, WRD et. al.)
  - (DiDonato, Elias, Schweiger, Thoma)
- Cumulative Bias SOP – (Lane Cameron, MEDN)
  - Analysis and Discussion of Benefits and Drawbacks
- Wetlands Monitoring Basics – (Brian Mitchell, NETN)
  - Post-meeting session planned for in depth discussions
- Seeps and Springs – (Gwen Gerber and Barry Long, WRB / WRD)
  - Monitoring Questions (Flow) and General Discussion
- Does Randomization "Wear Out"– (Roy Irwin, WRD)

Lessons Learned in Sonde Use

- A series of informal, open discussions stimulated by topics submitted to WRD and presented through this slide show.
- Purpose (Awareness):
  - Share information, tips, tools developed, and any guidance that may facilitate core parameters (and others) monitoring efficiencies (i.e. reduce manpower, time, cost).
  - Establish website (location) where this information may reside, be readily accessed and archived for future reference.
  - Examples – sensor specific information, calibration options and reference solutions for error checking, guidance documents, tools, data processing and analysis software, and training availability.
    - Participants: (Penoyer, Thoma, Elias, Schweiger, DiDonato joined by everyone else that currently uses or will be using multi-parameter water quality instruments to collect core parameter data (temp., SC, pH, DO) and others (Turb., Chlor.) etc.

Basic Lab Supplies / Accessories

Any Others?

Developing Servicewide Consistency in Sonde/Sensor Calibration and Error Checking (1 example)

- **Specific Conductance – a simple, single-point calibration using a conductivity cell** (raw conductivity measure that is temp. compensated to 25°C – other derived parameters from built–in algorithms include TDS and salinity)
  - Perform calibration in Specific Conductance mode (units mS/cm or μS/cm is typically vendor/sonde dependent)
  - Perform normally near room temperature (office, lab, in field as needed with or w/o error check under ambient conditions)
  - **Concept** - Use readily available **1413 μ/cm standard**, then error check against a 100 and 10,000 μs/cm standards - Why
    - SC/conductivity sensor has linear response over broad range (easily 10 to 10,000 μS/cm) so does not matter SC of environmental water
    - Minimizes influence of carry-over solution effects on calibration by using intermediate conductance (1413 μS/cm) standard – why a lower SC standard was not used that may be nearer your environmental water
    - Use conventional protocols using triple rinsing and drying sensors (chemwipes) before final calibration step

1. **Can anyone think of a good reason why a standard protocol along these lines should not be applied servicewide for at least calibration of sensors in freshwater use?**
    - Cooperator uses another method/protocol
    - Use until some better protocol comes along with better rationale (not likely to change?)

Basic Lab Supplies / Accessories in Sonde Use

(see notes w/ this slide for details & full list & discussion)

Any Others?

(See notes w/ this slide)

Lessons Learned

Calibration and Pre-Deployment (YSI sondes)

Common Problem	Remember to…	Additional Information
Instrument stops logging data during deployment.	Check free memory and battery life of the datasonde (not 650 handheld unit) before calibrating.	Both are reported in days. Make sure there is enough memory space and battery life for the length of deployment. Account for unexpected events that will extend deployments.
Unexpected temperature probe failure.	Check accuracy with a mercury **(NIST-traceable)** thermometer during calibration **(check)**.	The temperature sensor cannot be calibrated. According to YSI, all data should be considered suspect if there is an error of +/- 0.15° C from a traceable standard.*

Submitted by Eva DiDonato (SECN)

Lessons Learned

Calibration and Pre-Deployment (YSI)

Common Problem	Remember to…	Additional Information
Wiper parks over Optics.	Observe the wiper movements during calibration.	Wiper should always park 180 degrees from the optics. It should rotate twice in one direction and once in the opposite direction. If the wiper does not pass one or both of these tests, it is an indication of a problem and the probe should be sent in for repair.
pH readings won't stabilize during calibration.	Give the instrument/probe plenty of time to stabilize during calibration.	Static electricity and human body capacitance can cause pH readings to be jumpy or unstable during calibration. If this problem occurs try to stand 3 to 4 feet away from the sonde while pH readings stabilize. If the problem continues the probe may need to be reconditioned and/or a check for port contamination may need to be performed.

Eva DiDonato (SECN)

Lessons Learned

Calibration and Pre-Deployment (YSI)

Common Problem	Remember to…	Additional Information
Ignoring calibration error messages	NEVER ignore error messages!	If an error message appears try troubleshooting the problem, if unable to resolve DO NOT override the error message. The probe and/or sonde may need to be repaired.
Clock time on datasonde drifts over time. (official time source is (http://www.time.gov)	Check time on datasonde with a reliable source and re-adjust if off.	The sonde clock drifts over time and can cause data overlap between deployments and/or missing data points if not corrected.
Sample time in files are off.	Set instrument to start 1 minute before desired sample time.	Instruments take 60 seconds to warm up before a sample is taken. If, for example, the desired sample time is 09:00, set the instrument start time for 08:59.

Eva DiDonato (SECN)

Optical DO Probe

(GLKN - Eureka Environmental Manta Sonde & Amphibian display)

calibrate with 0 mg/L solution or 100% water saturated air

Problem:

0 mg/L soln. doesn't remain 0 for long, even unopened

Suggestion:

Calibrate in 100% water saturated air (easy and preferred method WRD)

Check periodically with Winkler titration or DO tables and saturated sample

or

(a prepared low DO solution as reference check – per WRD)

- can return used reference check solution to container to keep minimum headspace

J. Elias - GLKN

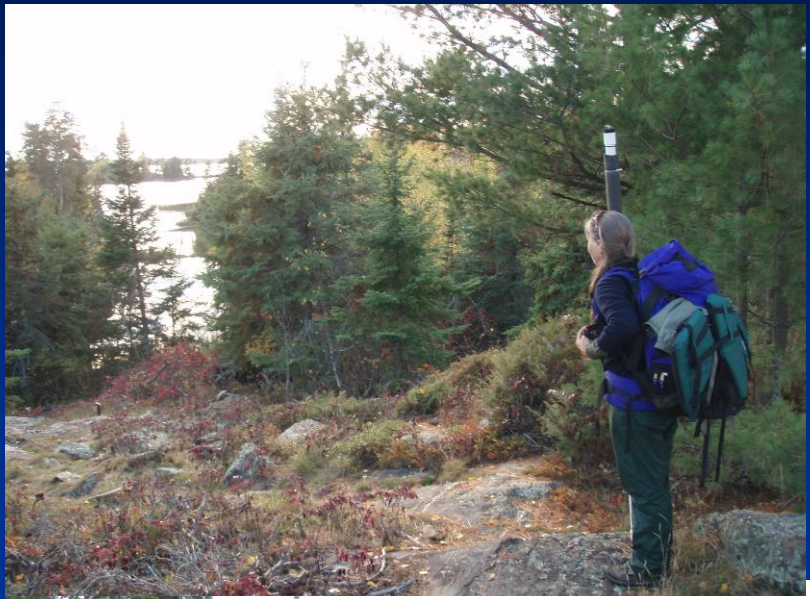
Handy Feature – Eureka Manta

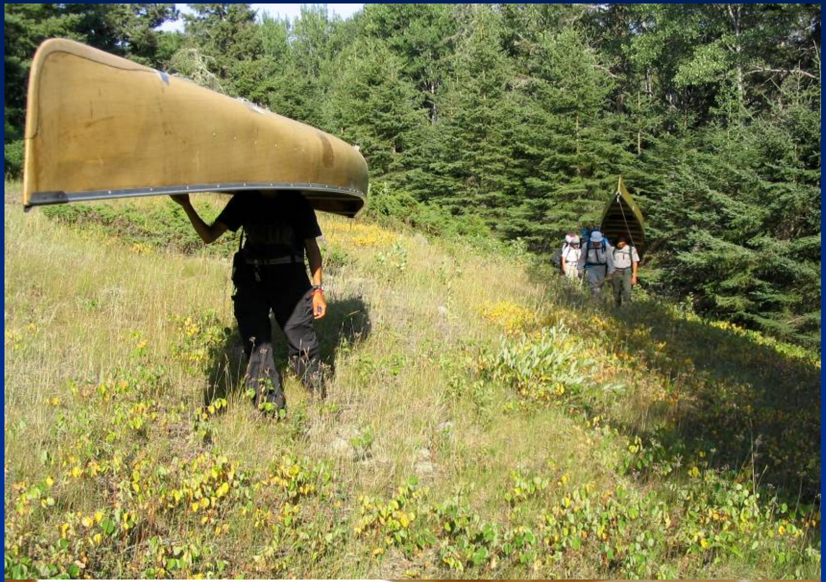
- Eureka sondes have a built-in barometer (converts more accurate depth measure from a transducer to BP measure while in air) – YSI, Hach-Hydro and In-Situ have barometer in handheld display.

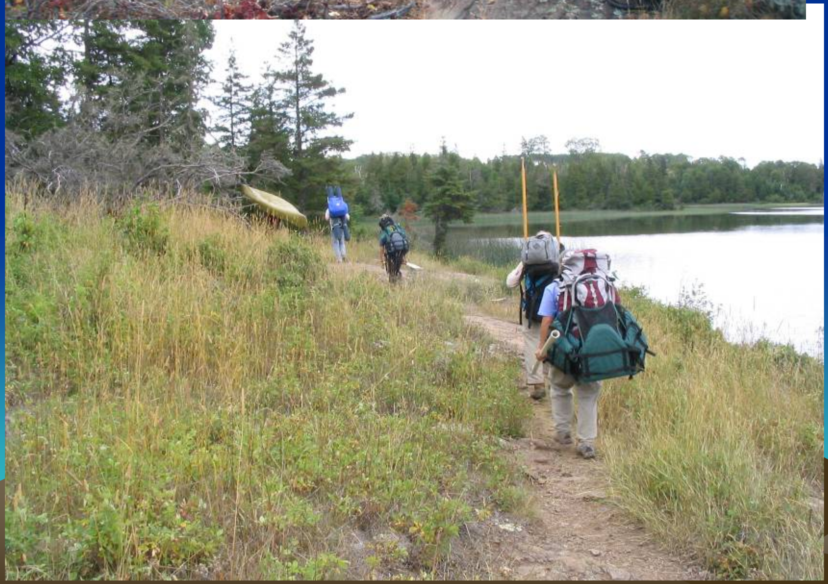
- Once calibrated for the day, if BP changes it's possible to reset calibration using new BP w/o recalibrating
  - true, BP/altitude change affects %DO saturation (only)
  - the mg/L measure is absolute and not affected by BP/altitude change
  - requires that you connect display / laptop to sonde to read and reset BP while in air

  * WRD recommends that the mg/L DO measure be <u>primary</u> and the %DO sat. be the <u>secondary</u> DO value reported. (Aquatic life stds. Are in mg/l)

Tips for Back Country Sampling







J Elias - GLKN

Tips for Back Country

Calibrate & check calibration in lab before leaving for field

J. Elias - GLKN

Tips for Back Country

Make a padded sleeve for protecting sonde during back country transport

J. Elias - GLKN

Tips for Back Country

Lighten load - use short cable for shallow lakes whenever possible

Every Sonde Has Its Quirks

- None is perfect, all perform adequately
  - YSI, Hach-Hydrolab, In-Situ, Eureka Environmental are approved multi-parameter instruments in VS monitoring
- Size differences matter in back country

J. Elias - GLKN

Avoiding Biological Cross Contamination: *Bythotrephes longimanus* (spiny waterflea)

Scrub hard equipment (sonde, secchi disk, water samplers, canoe, paddles)

Physically remove plants & animals incl. resting stages (eggs, cysts)

J. Elias - GLKN

Avoiding Biological Cross Contamination:
Bythotrephes longimanus (spiny waterflea)

Submerge soft equipment in 140°F several minutes

(lines – Secchi, Van Dorn, anchor; zoop nets; anchor bags)

J. Elias - GLKN

Problem:
Lines shrink when heated!

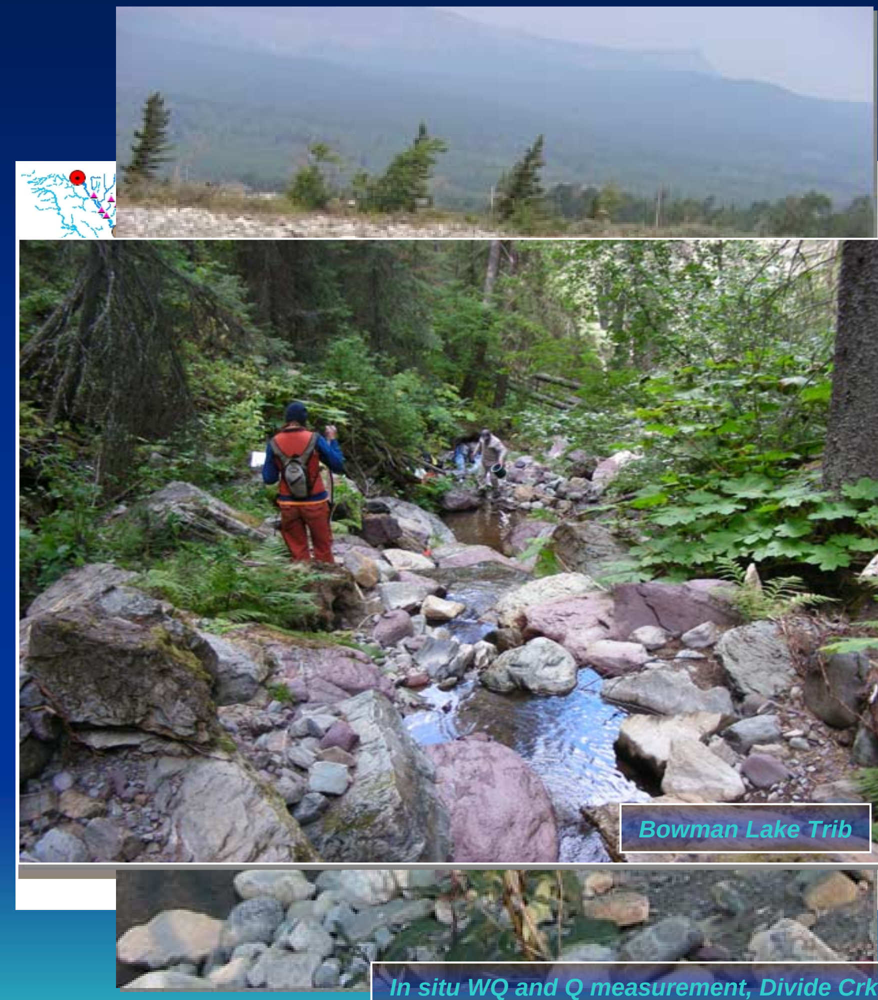
- Pre-treat lines before marking depths
- Check after treatments, ensure shrinkage has stopped

J. Elias - GLKN

ROMN Glacier Stream Protocol Pilot

In Situ Water Physiochemistry

- 3 year pilot
  - Survey (50, base flow), sentinel (3-5 on the hydrograph annually) and gradient sites (~10, baseflow), revisits, etc.
  - Multiple response measures: biological emphasis (bugs and periphyton), Q, WQ, quantitative physical habitat (local, meso and landscape scale)
- Hydrolab MS5 for Temp, pH, SC, LDO and turbidity (free from Hach for the season!)
  - HP iPaq PDA with an Otterbox and Hach Hydras3 Pocket
- Many sites were ‘randomly’ selected remote backcountry streams, 1+ day from base
  - All calibration done at headquarters base, no field calibration
  - Did this work?
- What is the needed response design for these parameters (longitudinal and lateral replication; indicate EWI/EDI sampling?)
  - Detailed reach level study of spatial structure in 5 parameters
  - +1800 measures at 29 sample events
  - Thalweg and cross sections



Bowman Lake Trib

In situ WQ and Q measurement, Divide Crk

B. Schweiger

ROMN Glacier Stream Protocol Pilot

In Situ Water Physiochemistry

- Qualitative gestalt is that 3(4?) were successfully collected (WRD criteria)
  - pH, SC: ~100% successfully taken; Temp: 60% (but low N and no indication that this was actually an issue); LDO: 86% of measurements successfully taken; Turbidity: only ~50% of measurements successfully taken
- Will be adding in select site calibration procedures next year, but this still must be a very small field effort
  - Would be greatly enhanced by a built in calibration process in the data logger

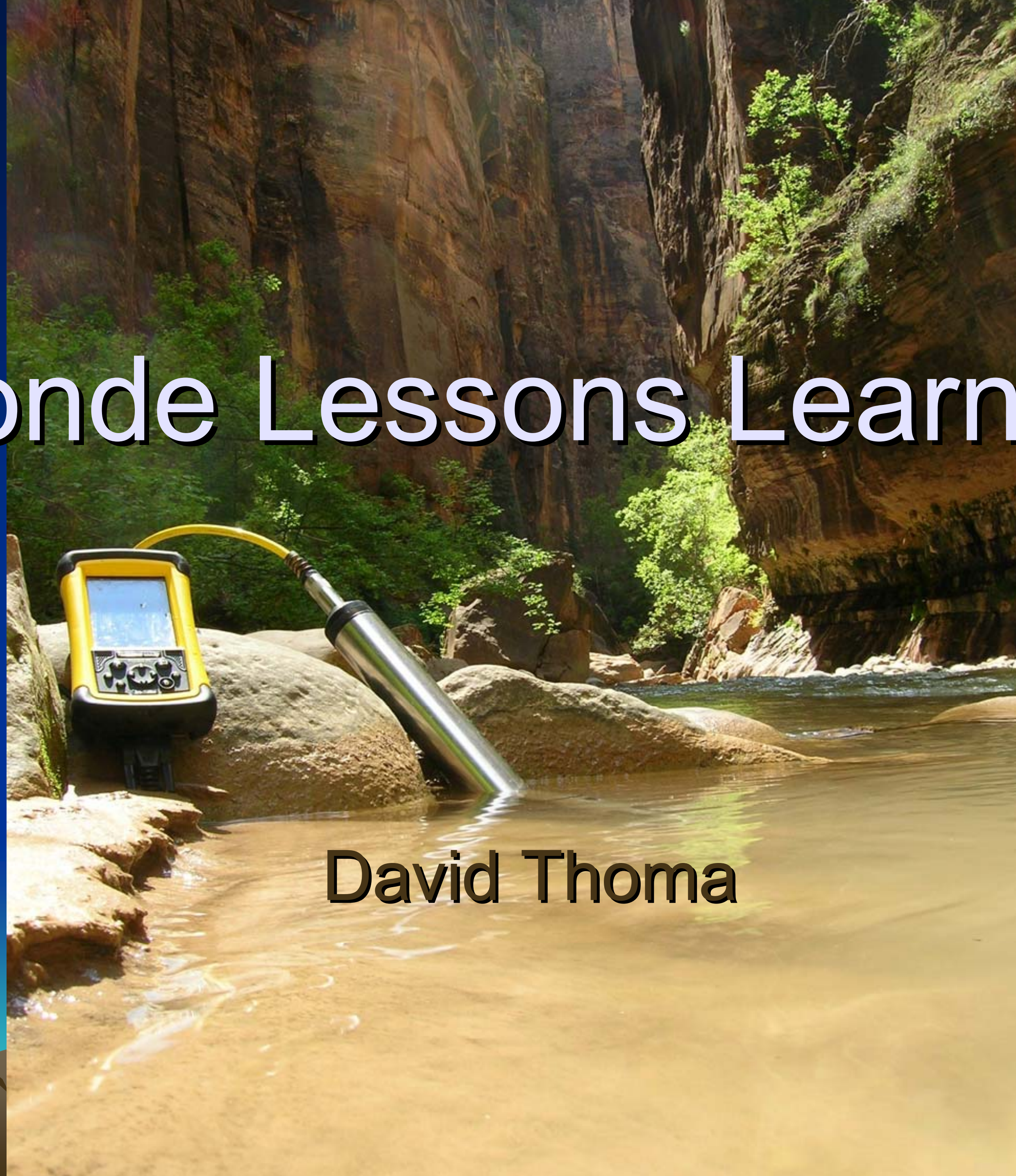
- Longitudinal profile (all 5 parameters variability within vs. among sites via variance components)
  - Site accounted for 76 to 99% of the total variance, transect location for <1 to 21% (turbidity), Replicates at a measurement point <1 to 1%
  - So (except for turbidity?), little variance within a sample event relative to across sites
  - Therefore single or a few measures may suffice as a 'representative' value for the sample event = confirms a well recognized and intuitive result.

- Lateral cross section (USGS SOP 'Percent Error' in SC across a cross section < 5% to allow a single thalweg water chemistry grab samples)
  - Specific conductance mean %error along transect = 0.56, only one site above threshold (Lower Camas Crk: 6.5) likely due to ground water upwelling at the transect
  - Not unexpected in lower order well mixed streams of GLAC
  - Confirms single thalweg depth integrated grab sample as appropriate method in most cases
  - However, larger, non wadeable systems in GLAC and perhaps LIBI will likely be more variable and require an EWI or EDI sample

- Next year: will collect a single set of well replicated (at the thalweg point) measures; will still conduct cross section to confirm EWI/EDI or not
  - Possible placement of probe at top of sample reach to collect continuous stream of in situ results during 4-6 hour long sample events

B Schweiger

Sonde Lessons Learned



David Thoma

Rotate Equipment

- I pulled a backup brand new sonde out of the box and it failed first time I tried to use it

Acceptable Ranges

- Don’t rely on Manufacturer
  - Accuracy claims
  - Calibration coefficient acceptable ranges

Measurement Sensitivity

	Manufacturer Specs	Long-run 2yr average (AMS)
Temp (^{o}C)	± 0.1	± 0.02 °C
SC (us/cm)	± 0.5% or 2 μS/cm	± 2.69 μS/cm
pH	± 0.09 pH units	± 0.02 pH
DO (mg/L)	± 0.2 mg/L	± 0.29 mg/L


D. Thoma

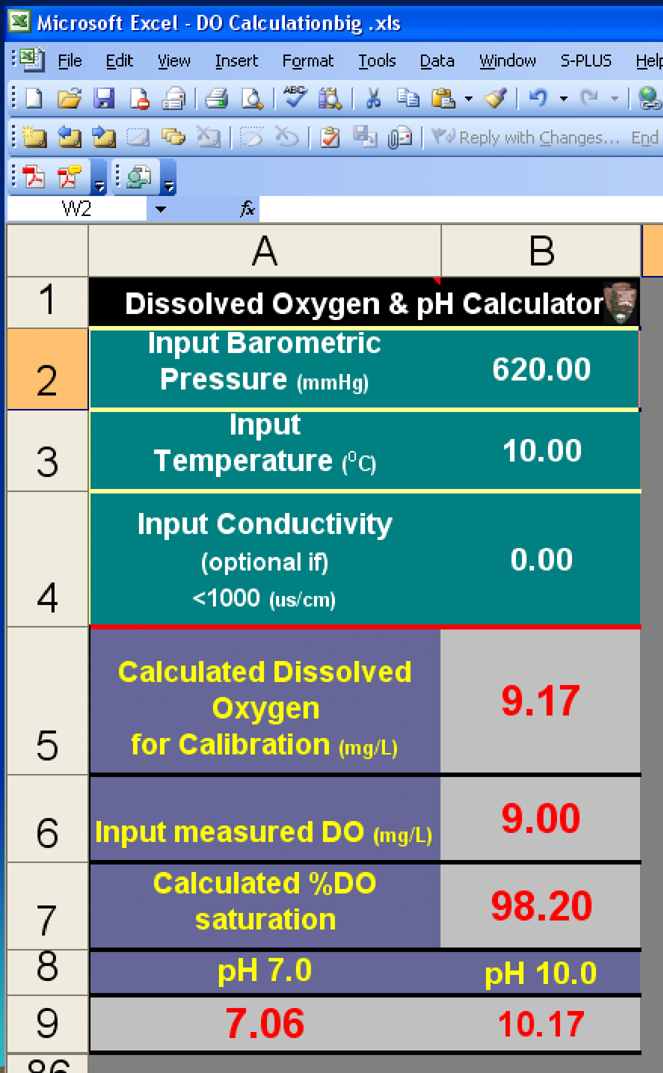
$AMS = 3.708 * Stdev_7$
99% confidence interval around mean

		Example AMS calculation			
	DO	Baro. Press.	Spc. Cond	Water	pH
Reading #	(mg/L)	(mm Hg)	(uS/cm@25 °C)	temp °C	unitless
1	4.75	573.02	525.43	19.46	7.61
2	4.75	573.05	525.59	19.46	7.61
3	4.75	573.05	525.92	19.46	7.61
4	4.75	573.05	525.75	19.46	7.61
5	4.74	573.05	526.03	19.46	7.61
6	4.74	573.02	525.79	19.47	7.61
7	4.74	573.05	525.79	19.48	7.61
AMS	0.018	0.046	0.740	0.026	0.000

Data Management Tools for Water Quality Monitoring

David Thoma
Northern Colorado Plateau
Inventory and Monitoring

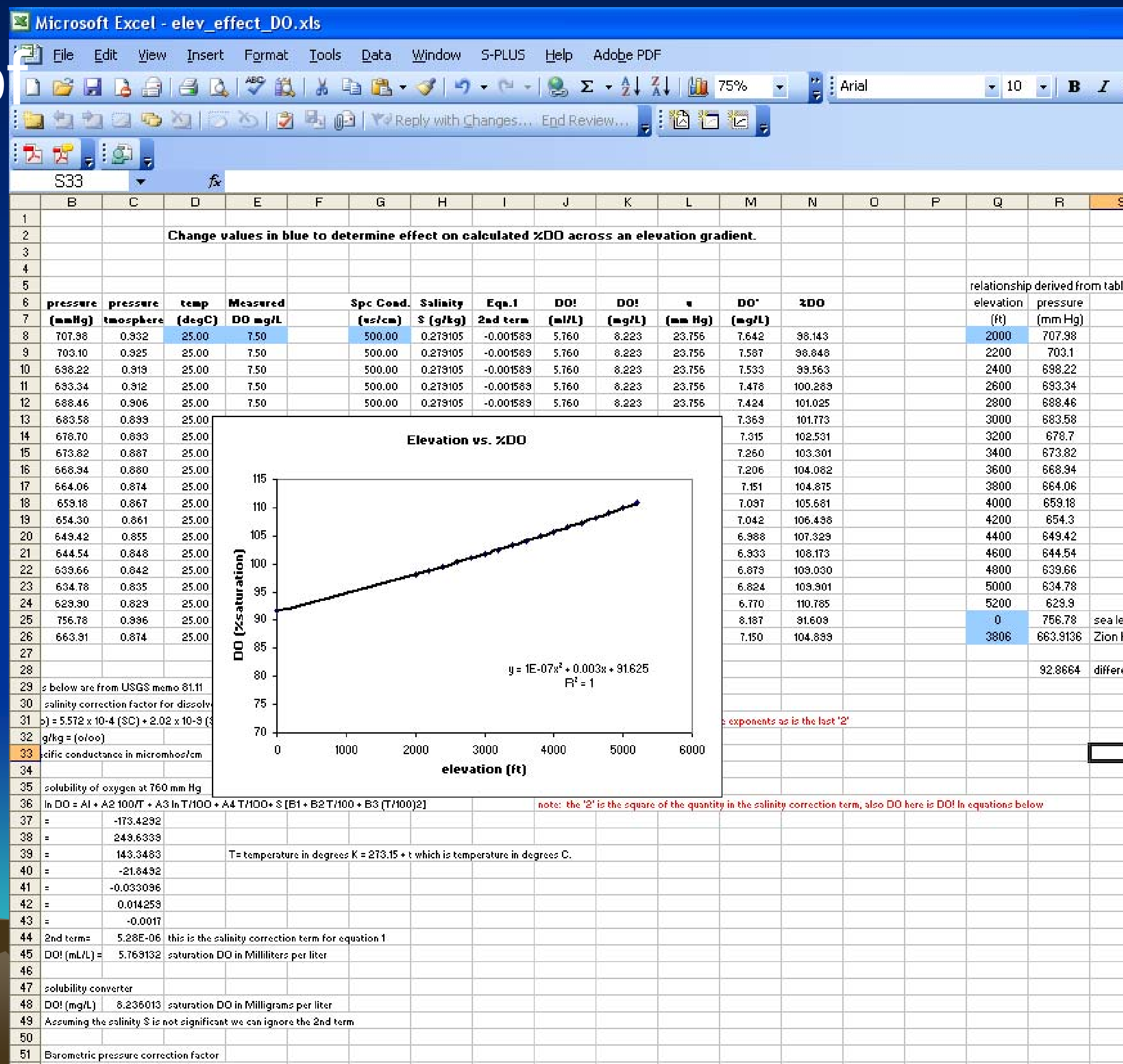
Dissolved Oxygen Calculator



- Uses USGS equations
- Replaces paper DO tables
- Compensates for
  - Salinity
  - Temperature
  - Pressure
- Temp compensates for pH

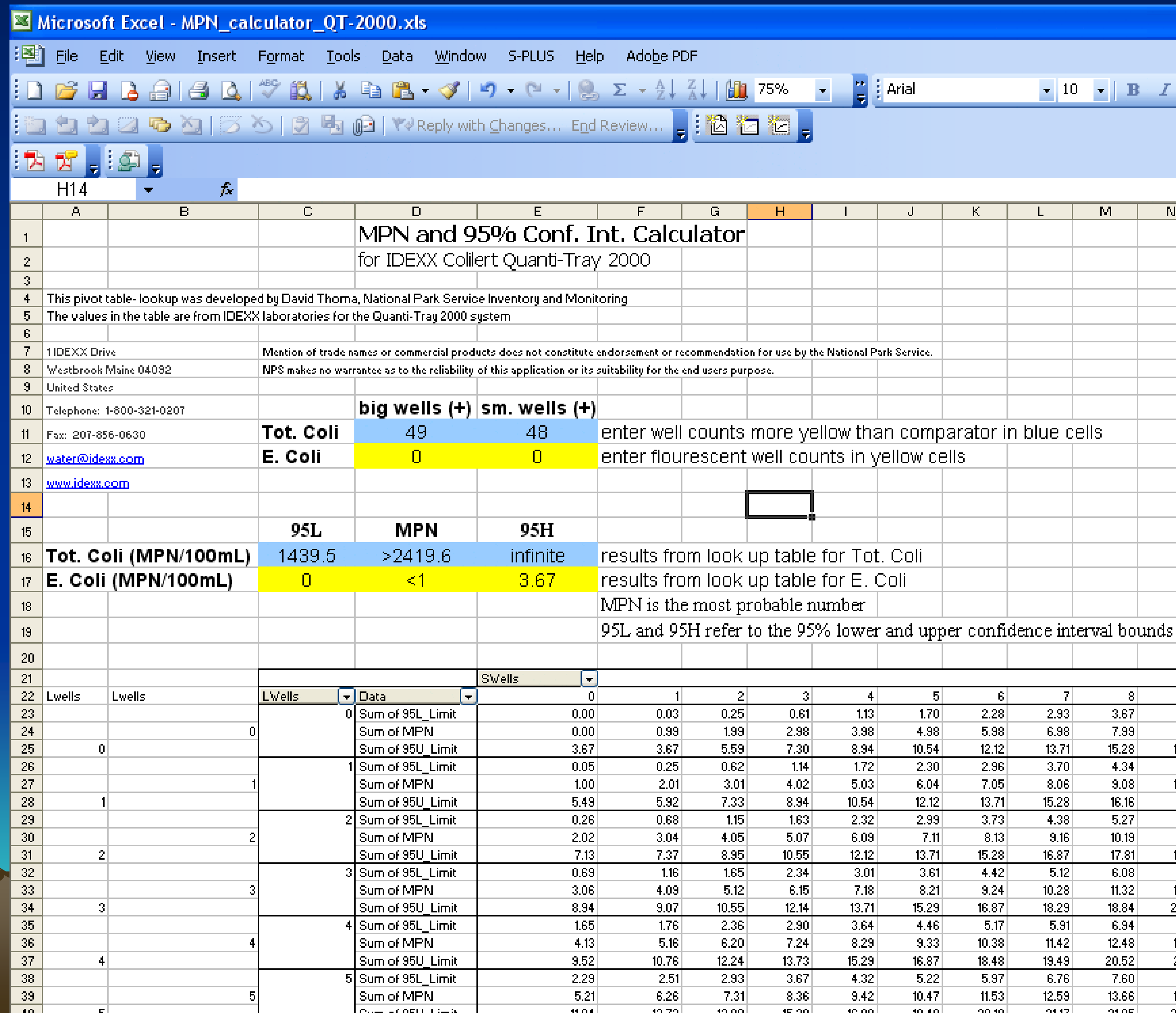
Dissolved Oxygen Model

- Model effects of
  - Elevation
  - Salinity
  - Temperature
  - Pressure



IDEXX Quantitray 2000 MPN Calculator

- Skip the lookup



Lwells	Lwells	LWells	Data	SWells 0	1	2	3	4	5	6	7	8
		0	Sum of 95L_Limit	0.00	0.03	0.25	0.61	1.13	1.70	2.28	2.93	3.67
	0		Sum of MPN	0.00	0.99	1.99	2.98	3.98	4.98	5.98	6.98	7.99
0			Sum of 95U_Limit	3.67	3.67	5.59	7.30	8.94	10.54	12.12	13.71	15.28
		1	Sum of 95L_Limit	0.05	0.25	0.62	1.14	1.72	2.30	2.96	3.70	4.34
	1		Sum of MPN	1.00	2.01	3.01	4.02	5.03	6.04	7.05	8.06	9.08
1			Sum of 95U_Limit	5.49	5.92	7.33	8.94	10.54	12.12	13.71	15.28	16.16
		2	Sum of 95L_Limit	0.26	0.68	1.15	1.63	2.32	2.99	3.73	4.38	5.27
	2		Sum of MPN	2.02	3.04	4.05	5.07	6.09	7.11	8.13	9.16	10.19
2			Sum of 95U_Limit	7.13	7.37	8.95	10.55	12.12	13.71	15.28	16.87	17.81
		3	Sum of 95L_Limit	0.69	1.16	1.65	2.34	3.01	3.61	4.42	5.12	6.08
	3		Sum of MPN	3.06	4.09	5.12	6.15	7.18	8.21	9.24	10.28	11.32
3			Sum of 95U_Limit	8.94	9.07	10.55	12.14	13.71	15.29	16.87	18.29	18.84
		4	Sum of 95L_Limit	1.65	1.76	2.36	2.90	3.64	4.46	5.17	5.91	6.94
	4		Sum of MPN	4.13	5.16	6.20	7.24	8.29	9.33	10.38	11.42	12.48
4			Sum of 95U_Limit	9.52	10.76	12.24	13.73	15.29	16.87	18.48	19.49	20.52
		5	Sum of 95L_Limit	2.29	2.51	2.93	3.67	4.32	5.22	5.97	6.76	7.60
	5		Sum of MPN	5.21	6.26	7.31	8.36	9.42	10.47	11.53	12.59	13.66

Systematic Error / Bias Calculator

- Assess effect of change
  - Staff
  - Meters
  - Methods
  - Indicators
- Part B Lite
  - Lots of guidance programmed into this spreadsheet
- NCPN SOP helps interpret results